Table 8.3-10
Warm Air Duct Furnaces and Unit Heaters

Reference	Category	Rating Conditions	Minimum Performance
AGA Z83.9-86	Duct Furnaces Gas-Fired	1. Max. Rated Cap.[1] Steady-State	E_t[2] 78%
		2. Min. Rated Cap.[1] Steady-State	E_t[2] 75%
AGA Z83.8-85	Unit Heaters Gas-Fired	1. Max. Rated Cap.[1] Steady-State	E_t[2] 78%
		2. Min. Rated Cap.[1] Steady-State	E_t[2] 75%
U.L 731-75	Unit Heaters Oil-Fired	1. Max. Rated Cap.[1] Steady-State	E_t[2] 81%
		2. Min. Rated Cap.[1] Steady-State	E_t[2] 78%

1. Provided and allowed by the controls.
2. E_t = thermal efficiency, 100% -flue losses.

§ 435.109 Service water heating systems.

9.1 General

9.1.1 This section contains minimum and prescriptive requirements for the design of Service Water Heating Systems.

9.1.2 A building shall be considered in compliance with this section if the following conditions are met:

9.1.2.1 The minimum requirements of section 9.3 are met; and

9.1.2.2 The Service Water Heating System design complies with the prescriptive criteria of section 9.4.

9.2 Principles of Design

9.2.1 Showerheads shall be designed to provide and maintain user comfort and energy savings. They should not use removable flow restricting inserts to meet flow limitation requirements.

9.2.2 Point of use water heaters shall be considered where their use will reduce energy consumption and is life cycle cost effective.

9.2.3 High temperature condensate, when returned to condensation pump tanks or other vented tanks, will have a certain portion flashed into steam, thus wasting energy. To conserve this energy, a heat exchanger shall be considered for use in the condensate return line to heat or preheat the service water, cool the condensate, and prevent flashing.

9.2.4 Storage may be used to optimize heat recovery when the flow of heat to be recovered is out of phase with the demand for heated water, or when energy use for water heating can be shifted to take advantage of off-peak rates.

9.3 Minimum Requirements

9.3.1 Sizing of Systems

9.3.1.1 Service water heating system design loads for the purpose of sizing and selecting systems shall be determined in accordance with the procedures described in chapter 54 of the *ASHRAE Handbook, 1987 HVAC Systems and Applications Volume,* or a similar computation procedure.

9.3.2 Equipment Efficiency

9.3.2.1 All water heaters and hot water storage tanks shall meet the criteria of Table 9.3–1. Where multiple criteria are listed, all criteria shall be met. Where no criteria are provided, no requirements need be met.

TABLE 9.3–1.—STANDARD RATING CONDITIONS AND MINIMUM PERFORMANCE OF WATER HEATING EQUIPMENT

[January 30, 1989]

Type	Fuel	Storage capacity (gal)	Input rating	Applicable test procedure	Minimum performance	
					DOE rating	Eff.
Storage water heaters	Electric	<120	<12 kW	DOE Test Procedures, 1985 Code of Federal Regulations Title 10, Part 430.	EF ..... gt;0.95–0.00132V.	
	.....	gt;120 (or) ...	gt;12 kW	ANSI C72.1—1972	.....	
	Gas	<100	<75,000 Btu/h	DOE Test Procedures, 1985 Code of Federal Regulations Title 10, Part 30.	EF gt;0.62–0.0019V	
	.....	gt;100 (or) ...	gt;75,000 Btu/h	ANSI Z21.10.3–198 Gas Water Heaters w/Addenda Z21.10.3a—1985.	.....	E_t 77%
	Oil	..... <50.	<75,000 Btu/h	DOE Test Procedures, 1985 Code of Federal Regulations Title 10, Part 430.	EF gt;0.59–0.0019V	
	.....	.....	<105,000 Btu/h	.....	gt;0.59–0.0019V	
	.....	gt;50 (or)	gt;105,000 Btu/h	.....	.....	E_c 83%

TABLE 9.3–1.—STANDARD RATING CONDITIONS AND MINIMUM PERFORMANCE OF WATER HEATING EQUIPMENT (CONT.)

[January 30, 1989]

		Type		Applicable test procedure	Minimum performance	
Class	Fuel	Capacity	Input rating			
Unfired Storage	1	All Volume	All Inputs	.....	..... HL. <6.5 Btu/h ft^2.	
Instantaneous	Gas	.....	All Inputs	ANSI Z21.10.3—1984	E_t 80%	
	Distill Oil	.....	All Inputs	.....	E_c 83%	
Pool Heaters	Gas/Oil	.....	All Inputs	ANSI Z21.56—1986	E_t ..... 78%[c]	

Notes for Table 9.3–1:

Terms Defined:

1. EF = Energy factor, overall heater efficiency by DOE Test Procedure E_t = Thermal efficiency with 70 °F, eT E_c = Combustion efficiency, 100 percent—flue loss when smoke = 0 (trace is permitted) HL = Heat loss of tank surface area V = Storage volume in gallons

9.3.2.1.1 *Exception to section 9.3.2.1*

(a) storage water heaters and hot water storage tanks having more than 500 gallons of storage capacity need not meet the heat loss (HL) requirements of Table 9.3–1 if the tank surface area is thermally insulated to R–12.5 and if a standing pilot light is not used.

9.3.2.2 *Heat Traps.* Storage water heaters not equipped with integral heat traps and having vertical pipe risers shall be installed with heat traps on both the inlet and outlets. The heat trap shall be installed directly, or as close as possible to the outlet fittings. Circulating systems need not employ heat traps.

9.3.2.2.1 A heat trap may take the form of a bent piece of tubing that forms a loop of 360 degrees; an arrangement of pipe fittings, such as elbows, connected so that the inlet and outlet piping make vertically upward runs just before turning downward to connect to the water heater's inlet and outlet fittings; a commercially available heat trap; or any other type that effectively restricts the natural tendency of hot water to rise in the vertical pipe during standby periods.

9.3.2.2.2 When the water heater outlet is directly horizontal out of the tank, or is piped with an elbow on the vertical outlet and then downward, this piping arrangement itself is effectively a heat trap and a separate heat trap is not then needed.

9.3.3 Piping Insulation

9.3.3.1 For circulating systems, piping insulation shall conform to the requirements of Table 7.3–1 or an equivalent level as calculated in accordance with Equation 7.3–1.

9.3.3.2 For non-circulating systems, the first 8 ft of piping from a storage system that is maintained at a constant temperature shall be insulated in accordance with Table 7.3–1, or an equivalent level as calculated in accordance with Equation 7.3–1. Systems without a heat trap to prevent circulation due to natural convection shall be considered circulating systems.

9.3.4 Controls

9.3.4.1 *Temperature.* Service water heating systems shall be equipped with temperature controls capable of adjustment from 90 °F to a temperature setting compatible with intended use, except for systems serving residential dwelling units may be equipped with controls capable of adjustment down to 110 °F only. (See *ASHRAE Handbook, 1987 Systems and Applications Volume*, Chapter 54, Table 3).

9.3.4.1.1 Where temperatures higher than 120 °F are required at certain outlets for a particular intended use, separate remote heaters or booster heaters shall be installed for those outlets unless it can be shown by calculation that either energy is not saved by the application of this requirement or that the total cost over the life of the equipment is not reduced.

9.3.4.1.2 *Circulating Hot Water Systems and Heated Pipes.* Systems designed to maintain temperatures in hot water pipes, including circulating hot water systems and heat tape on water pipes, shall be equipped with automatic controls that can be set to turn off the system when hot water is not required.

9.3.5 Equipment and Control Requirements for the Conservation of Hot Water

9.3.5.1 Showers used for other than safety reasons shall limit the maximum hot water discharge to 2.75 gpm when tested according to *ANSI A112.18.1M–1979*, ''Finished and Rough Brass Plumbing Fixtures''. The designer shall evaluate the use of lower flow showerheads than 2.75 gpm, particularly for heavily used facilities. Removable flow restricting inserts shall not be used in showerheads to meet this criterion. When flow restricting inserts are used as a component part of a showerhead, they shall be mechanically retained at the point of manufacture. [Mechanically retained means a pushing or pulling force to remove the flow restricting insert at 8 pounds or more.] This requirement shall not apply to showerheads that will cause water to leak significantly from areas other than the spray face, if the flow restricting insert were removed.

9.3.5.2 Lavatories in public restrooms, with the exception of lavatories for physically handicapped persons, shall be equipped with devices that:

9.3.5.2.1 Limit the flow of hot water to either:

(a) A maximum of 0.5 gpm;

(b) 0.75 gpm if a device or fitting is used that limits the period of water discharge, such as a foot switch, fixture occupancy sensor; or

(c) 2.5 gpm if equipped with a self-closing valve;

9.3.5.2.2 Either be equipped with a foot switch or occupancy sensor or similar device or limit delivery with a self-closing valve or a foot switch to a maximum of 0.25 gallons of hot water for circulating systems;

9.3.5.2.3 Limits delivery with a self-closing valve or a foot switch to a maximum of 0.50 gallons for non-circulating systems; and

9.3.5.2.4 Limits the outlet temperature to a maximum 110 °F.

9.3.6 Swimming Pools

9.3.6.1 *Pool Heaters.* All pool heaters shall meet the criteria of Table 9.3–1 and be equipped with a readily accessible ''on-off'' switch to allow system shut-off without adjusting the thermostat setting and, when applicable, allow restarting without manually relighting the pilot light.

9.3.6.2 *Pool Covers.* Outdoor heated swimming pools shall be equipped with a pool cover. However, pools deriving over 70% of the energy for heating from non-depletable sources or from recovery of energy that would otherwise be wasted (computed over an operating season) need not be equipped with pool covers.

9.3.6.3 *Time Switches.* Time switches shall be installed on all swimming pool pumps and all electric swimming pool heaters. These switches shall allow for the shutdown of heaters during hours of peak utility demand except as is necessary in peak period operation to maintain water in a clear and sanitary condition in keeping with applicable public health standards.

9.3.6.3.1 *Exceptions to section 9.3.5.3:*

(a) Where public health standards require 24 hour operation of pumps; and

(b) Pumps are required to operate solar pool heating systems.

9.4 Service Hot Water Heating Systems—Prescriptive Compliance Alternative

9.4.1 Combination Service Water Heating/Space Heating Equipment

9.4.1.1 Water heaters used for combination service water and space heating shall meet the appropriate minimum efficiency requirements of both section 8.3 and 9.3.

9.4.1.2 Combination space heating and service water heating equipment shall only be used when at least one of the following conditions is met:

9.4.1.2.1 where the annual space heating energy use is less than 50% of the annual service water heating energy use;

9.4.1.2.2 where the energy input or storage volume of the combined boiler or water heater is less than twice the size of the smaller of the separate boilers or water heaters otherwise required;

9.4.1.2.3 where calculations show that the combined system uses no more energy than separate systems that meet the requirements of sections 8.3 and 9.3; or

9.4.1.2.4 where the input to the combined boiler is less than 150,000 Btu/h.

9.4.1.3 Combination function equipment (space heating, service water heating, cooling, etc.) shall comply with minimum efficiency requirements in accordance with nationally recognized test procedures. Where such procedures are not available for particular equipment designs, compliance shall be determined based on the function representing the maximum annual energy consumption, using data provided by equipment and component manufacturers.

9.4.2 Additional Equipment Efficiency Measures

9.4.2.1 *Electric Water Heaters.* In applications where water temperatures not greater than 145 °F are required, an economic evaluation shall be made on the potential benefit of using an electric heat pump water heater(s) instead

of electric resistance water heater(s). The analysis shall compare the extra costs of the heat pump unit with the benefits in reduced energy costs, less increased maintenance costs, over the estimated service life of the heat pump water heater.

9.4.2.1.1 *Exception to section 9.4.2.1:*

(a) Electric resistance water heaters used in conjunction with site-recovered or non-depletable energy sources or off-peak heating with thermal storage.

9.4.2.2 *Gas-Fired Water Heaters.* All gas-fired storage water heaters that use indoor air for combustion or draft hood dilution and that are installed in a conditioned room shall be equipped with a vent damper unless the water heater is already so equipped. Unless the water heater has an available electrical supply, the installation of such a vent damper shall not require an electrical connection. The vent damper shall be listed as meeting appropriate ANSI standards and shall be installed in accordance with manufacturer's instructions and local codes.

9.4.2.2.1 *Exception to section 9.4.2.2:*

(a) where the cost of the damper exceeds the value of reduced energy costs over the damper's lifetime.

9.4.3 Use of Waste Heat, Solar Energy, and Thermal Storage

9.4.3.1 An evaluation shall be made of the potential for the use of condenser heat, waste energy, solar energy, or off-peak heating with thermal storage to reduce water heating energy cost.

9.4.3.2 Storage shall be used to optimize heat recovery when the flow of heat to be recovered is out of phase with the demand for heated water, or when energy use for water heating can be shifted to take advantage of off-peak rates.

[54 FR 4554, Jan. 30, 1989, as amended at 55 FR 23869, June 12, 1990; 59 FR 18294, Apr. 18, 1994]

§ 435.110 Energy management.

10.1 General

10.1.1 This section contains minimum requirements for building energy management systems. It describes the energy measurement, control, testing and documentation that shall be provided to the building owner. The intent is to minimize energy use by providing the building operator with design, construction and equipment data, along with a means of testing the completed facility.

10.1.2 A building shall be considered in compliance with this section if the minimum requirements of Section 10.3 are met.

10.2 Principles of Design

10.2.1 Energy Management Control Systems

10.2.1.1 An energy management control system is critical to the effective management of building energy. Energy management systems require measurements at key points in the building system and must be capable of part-load operation recognition and be equipped with controls to match system capacity to load demands.

10.2.1.2 Controls cannot correct inadequate source equipment, poorly selected components, or mismatched systems. Energy efficiency requires a design that is optimized by realistic loads prediction, careful system selection, and full control provisions.

10.2.2 Building Operating Documentation

10.2.2.1 The building construction drawings and specifications must show system types, sizes, performance criteria, controls, and materials intended for use prior to construction. The system designer shall provide or specify that documentation be provided for the education and guidance of the building operator showing the actual elements that have been installed, how they have been installed, how they performed during testing, and how they operate as a system in the completed facility. Since minimum energy use is the ultimate goal, operating procedures are one of the major factors in controlling energy use in buildings. The activities of building occupants and operators can result in differences as great as two to one in the energy consumption of essentially similar buildings. While neither the designer nor these standards can control the way the building is actually operated, the designer shall contribute to the